DOCUMENT RESUME

ED 299 314 TM 012 204

AUTHOR Riddle, Wayne
TITLE Comparison of the Achievement of American Elementary and Secondary Pupils with Those Abroad--The Examinations Sponsored by the International Association for the Evaluation of Educational Achievement (IEA).
INSTITUTION Library of Congress, Washington, D.C. Congressional Research Service.
PUB DATE 30 Jun 86
NOTE 42p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; Comparative Analysis; Cross Cultural Studies; Elementary School Students; Elementary Secondary Education; *Foreign Countries; Mathematics Achievement; *Mathematics Tests; *Science Tests; Secondary School Students; Testing Programs; *Test Interpretation
IDENTIFIERS Between Group Differences; Cross Cultural Testing; *International Evaluation Education Achievement

ABSTRACT

Available sources of information on academic achievement levels of American elementary and secondary school students as compared to their counterparts in major foreign countries are analyzed. Focus is on testing conducted by the International Association for the Evaluation of Educational Achievement (IEA) in Stockholm (Sweden). The IEA tests represent an attempt to: (1) develop comparable tests reflecting both international standards and national curricula; (2) assess representative samples of students in voluntarily participating countries; and (3) analyze the resulting scores in relation to additional information concerning students' background characteristics and attitudes. Findings from current major international assessments of mathematics and science achievement are reviewed, and possible reasons for the sometimes comparatively lower level of performance by American students in such examinations are analyzed. The testing process established by the IEA is described, and results for the first round of IEA testing are interpreted, with an emphasis on American students' scores. Available IEA second round results are also assessed. The appendix reviews significant, recent, non-IEA research on comparative achievement of American students in relation to students of other major counties, namely Japan. Nine data tables are provided. (TJH)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

86-683 EPW

Congressional Research Service
The Library of Congress

Washington, D.C. 20540

ED299314

COMPARISON OF THE ACHIEVEMENT OF AMERICAN ELEMENTARY AND SECONDARY PUPILS WITH THOSE ABROAD--THE EXAMINATIONS SPONSORED BY THE INTERNATIONAL ASSOCIATION FOR THE EVALUATION OF EDUCATIONAL ACHIEVEMENT (IEA)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Wayne Riddle

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Wayne Riddle
Specialist in Education
Education and Public Welfare Division
November 27, 1984
Updated June 30, 1986

TM012204

BEST COPY AVAILABLE

ABSTRACT

Recently, there has been widespread public interest in the academic achievement levels of American pupils compared to those of pupils in major foreign nations. This paper provides a discussion of available sources of information on comparative achievement levels, including findings from current major international assessments of mathematics and science achievement. Possible reasons for the sometimes lower level of American performance in such examinations are also analyzed.

CONTENTS

ABSTRACT.....iii

INTRODUCTION..... 1

THE IEA TESTING PROCESS..... 2

FIRST ROUND IEA TEST RESULTS..... 7

ANALYSIS OF UNITED STATES SCORES ON FIRST ROUND IEA TESTS..... 11

AVAILABLE IEA SECOND ROUND TEST RESULTS..... 22

APPENDIX: SIGNIFICANT, RECENT, NON-IEA RESEARCH ON COMPARATIVE ACHIEVEMENT..... 31

REFERENCES..... 37

COMPARISON OF THE ACHIEVEMENT OF AMERICAN ELEMENTARY AND SECONDARY PUPILS WITH THOSE ABROAD--THE EXAMINATIONS SPONSORED BY THE INTERNATIONAL ASSOCIATION FOR THE EVALUATION OF EDUCATIONAL ACHIEVEMENT (IEA)

INTRODUCTION

At several points in American history, there has been widespread public concern regarding the academic achievement level of American pupils compared to that of pupils in certain foreign nations. Such periods have included the years immediately following the launching of the Soviet "Sputnik" satellite in 1958, and the current period when concern about a widely perceived decline in the quality of American education has been exacerbated by increased economic competition from such nations as Japan. The level of interest and concern regarding the relative academic performance of American pupils is not matched by extensive availability of valid, current, and comparable international achievement test results. Only tests which are carefully and specifically designed for the purpose of international comparative testing, and which are administered to representative samples of comparable pupil populations in different countries, can be considered valid measures of international achievement levels.

There is one organization and system which has been established to provide such comparative international achievement data for elementary and secondary pupils--the International Association for the Evaluation of Educational Achievement (IEA), headquartered in Stockholm, Sweden (although incorporated in

Belgium). This organization, founded in 1961, sponsored the preparation, administration, and analysis of a series of examinations in mathematics, science, reading comprehension, literature, civic education, and French and English as foreign languages, to pupils at 3 age/grade levels in 12-20 countries (depending on the specific test and age/grade level) between 1964 and 1970. These test results, and the subsequent analyses thereof, have been the most substantial and reliable available source for information on comparative academic achievement levels, although they are rather dated. These 16-22 year old findings are currently being supplemented by the results of a second round of IEA tests in mathematics, science, and written composition. Some results from these second round tests for the United States recently have been made available with information on the relative position of American results compared to those for other nations in the mathematics test. More complete information on United States and foreign scores on the latest IEA tests will become available in the future.

The purpose of this paper is to provide an introduction to the IEA testing process, a discussion of the results from the first (and to the extent available, the second) round IEA tests, and an analysis of the pattern of scores for the United States. An appendix will provide a brief discussion of two non-IEA international achievement testing projects, which focus primarily on comparison of American achievement with that of Japan.

THE IEA TESTING PROCESS

The establishment of the original International Project for the Evaluation of Educational Achievement derived from a series of meetings at the Education Institute of the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1959. However, the IEA is an independent organization, not a

part of the United Nations or any other international organization. The IEA is housed at the University of Stockholm and maintains cooperative relationships with that institution as well as education research organizations and agencies (both public and private) in all of the nations that are members of the IEA (currently approximately 46 nations). The IEA member nations include the highly developed nations of Western Europe, North America, and Japan plus several lesser developed nations in Africa, Asia, and South America. With limited exceptions (involving Hungary, Poland and the Peoples' Republic of China), the Communist nations have chosen not to participate in the IEA or its testing activities. The Soviet Union, in particular, seems to consider the average achievement levels of its pupils to be "state secrets" of potentially strategic importance, which it would rather keep to itself. Also, the Soviets appear to be ideologically uncomfortable with certain of the assumptions regarding the distribution of ability and achievement among pupils, the selection of representative pupil groups to be tested, and the collection of pupil and school system background data underlying the IEA tests.

The first round of IEA tests began with a 12-nation mathematics examination conducted in 1964. This was followed in the late 1960s through 1970 by a series of tests in reading comprehension, science, literature (in the students' own language), civic education, and French or English as foreign languages. Each of the first round tests (and, with minor modifications, the second round tests) administered separate examinations for pupils at three age/grade levels, as follows:

—"Population I": 10-year olds (5th grade in the United States, not used for the mathematics test),

—"Population II": 14-year-olds (9th grade in the United States, 13-year-olds for the mathematics test), and

--"Population IV": pupils in the last year of pre-university secondary education (the age/grade to which this refers will vary by country, as described further below).

Perhaps the most significant--and for purposes of making valid international comparisons, troubling—aspect of the selection of population groups to be tested is the variation among nations with respect to population IV. First, in certain nations with extended upper secondary education programs for students intending to attend a university (such as France, England, or West Germany), the pupils in population IV will be in their 13th (not 12th, as in the United States or Japan) year of elementary-secondary education. 1/ Of probably greater significance is the wide variation among nations, which was even greater at the time of the first round tests, in the proportion of youth who attend academically oriented, as opposed to vocational, or none at all, upper secondary schools. The importance of this factor in the interpretation and analysis of the IEA results for population IV will be discussed further below (section D of this paper).

There are several reasons why the IEA examinations represent the only available, comparable, multi-nation achievement tests (and why even the IEA tests have been so infrequently administered). In order to be valid, fair and comparable, such tests have to be developed via an extensive process involving educational testing experts from each of the participating nations. The tests

---

1/ For a detailed discussion of this topic see, U.S. Library of Congress. Congressional Research Service. Public Secondary Education Systems in England, France, Japan, The Soviet Union, The United States, and West Germany: A Comparative Analysis. Report No. 84-770 EPW by Wayne Riddle. Washington, 1984.

should maintain a delicate balance between determining and upholding international standards regarding what pupils should know in certain subject areas at certain age levels, while attempting simultaneously to reflect the actual curriculum of each country in an equal proportion (i.e., ideally, the pupils in each country should have been exposed to an equal proportion of the material covered by the tests). These difficulties are exacerbated by differences in language and curricular emphasis among countries. In addition, the costs of developing and administering the tests are considerable, and secure sources of these funds generally have not been available (United States participation has been supported by a combination of foundation grants, United States Office/ Department of Education, and National Science Foundation funds). Further, students vary widely among countries in their familiarity with testing procedures or experience in taking national or international tests; international tests may measure such "test wiseness" as much as mastery of the substantive material covered by the test. Another potential source of difficulty is political--for example, nations may choose not to participate for fear of low scores. Finally, numerous timing, coordination, and methodological problems hamper any such international testing effort.

The complexity of the IEA efforts may be indicated by the scale of the testing programs. The first round mathematics test involved 33,000 students in 5,450 schools in 12 countries. The largest of the first round tests, that in science, involved 258,000 students in 9,700 schools in 19 countries, with the test conducted in 14 different languages. Twenty-five nations have participated in the second-round IEA science tests, and 22 nations in the second-round mathematics test. Both the first and second round IEA tests have gathered extensive data on not only the academic or cognitive achievement level of pupils,

but also on several affective, behavioral or attitudinal measures, as well as background characteristics on students and their schools. The purpose of collecting background data is to analyze possible relationships between these factors and pupil achievement. In both first and second rounds of tests, the IEA has also gathered extensive information on the curricula of each nation in the relevant subjects. These latter aspects of the IEA's work will be considered only briefly in this paper, since they deserve to be discussed thoroughly only after introduction to the context of educational resource input-achievement output analysis and subject-specific curricular issues, respectively, which are beyond the scope of this paper.

In the United States, the University of Chicago was the coordinating institution for American participation in the first mathematics test, while Teachers College at Columbia University was the national center for the other first round tests. The second round test in mathematics is being coordinated by Professor Kenneth Travers of the University of Illinois, while United States participation in the second round science test is being coordinated by Professor Willard Jacobson of Teachers College. (The second round test in writing is at an earlier state of development than these 2).

In summary, the IEA tests are cross-sectional, that is, given to students at different age/grade levels at the same point in time—as opposed to longitudinal tests that follow a single age/grade group through time and are efforts to: (a) develop comparable tests reflecting both international standards and national curricula; (b) administer these tests to representative samples of students in voluntarily participating countries; and (c) analyze the resulting scores in relation to additional information gathered on students' background characteristics and attitudes. In the next section of this paper, summaries of the test scores for the first round examinations are presented. This is

followed by a discussion of the currently available data from the second round tests in mathematics and science.

FIRST ROUND IEA TEST RESULTS

Given the number of different tests and age/grade groups tested, the varying number of nations participating in each test, and the concern of many of those involved in the IEA process that test results not be simplistically interpreted as part of an "educational Olympics," IEA test results have been reported or displayed in a variety of ways, many of them not immediately comprehensible. Nevertheless, it is inevitable that United States policy makers, educational analysts, and the public at large will be intensely interested in the average scores of United States students compared to those of pupils from other nations. Tables 1-3 display basic results from the first round tests. Table 1 shows simply the number of nations with average (mean) scores below and above the United States mean on each test and age/grade level. Tables 2 and 3 provide more detailed information for the subjects on which most recent American interest and concern about relative achievement levels have been focused: mathematics and science.

TABLE 1. Number of Nations With Average (Mean) Score Below and Above the U.S. Mean in the First Round IEA Tests, by Subject and Age/Grade Level

	Pop. I		Pop. II		Pop. IV	
Test	Above U.S.	Below U.S.	Above U.S.	Below U.S.	Above U.S.	Below U.S.
Mathematics	na*	na	8	1	11	0
Science	4	11	7	10	13	4
Reading Comprehension	8	5	2	12	11	3
Civic Education	na	na	2	6	5	2
Literature	na	na	2	7	4	5
French Reading Comprehension	na	na	5	0	6	1
French Writing	na	na	2	2	5	1
French Listening Comprehension	na	na	3	2	5	2
French Speaking	na	na	2	2	4	1

* na: not applicable.

Sources: Wolf, Richard M. Achievement in America, p. 54; and Torsten Husen, International Study of Achievement in Mathematics, p. 22 and 24.

TABLE 2. Scores on the IEA First Round Science Test
by Age/Grade Group and Country
(Average number of questions answered correctly)

Country	Score		
	Pop. I	Pop. II	Pop. IV
(Maximum Score)	(40)	(80)	(60)
Australia	na	24.6	24.7
Belgium (Flemish)	17.9	21.2	17.4
Belgium (French)	13.9	15.4	15.3
Chile	9.1	9.2	8.8
England	15.7	21.3	23.1
Federal Republic of Germany	14.9	23.7	26.9
Finland	17.5	20.5	19.8
France	na	na	18.3
Hungary	16.7	29.1	23.0
India	8.5	7.6	6.0
Iran	4.1	7.8	10.2
Italy	16.5	18.5	15.9
Japan	21.7	31.2	na
Netherlands	15.3	17.8	23.3
New Zealand	na	24.2	29.0
Scotland	14.0	21.4	23.1
Sweden	18.3	21.7	19.2
Thailand	9.9	15.6	12.4
United States	17.7	21.6	13.7

Source: Inkeles, Alex. National Differences in Scholastic Performance, Comparative Education Review, October 1979, p. 389.

TABLE 3. Scores on First Round IEA Mathematics Test, by Age/Grade Level and Country (Average number of questions answered correctly)

Country	Pop. II	Pop. IV*
(Maximum Score)	(68)	(69)
Australia	20.2	21.6
Belgium	27.7	34.6
England	19.3	35.2
Finland	24.1	25.3
France	18.3	33.4
Federal Republic of Germany	na	28.8
Israel	na	36.4
Japan	31.2	31.4
The Netherlands	23.9	31.9
Scotland	19.1	25.5
Sweden	15.7	27.3
United States	16.2	13.8

* Note: Population IV scores are those only for students taking mathematics courses in their terminal year of secondary education.

Source: Husen, Torsten, International Study of Achievement in Mathematics, p. 22 and 24.

Certain general patterns are evident from these test scores:

--the scores of the less developed countries (Chile, India, Iran, and Thailand) are very much below those of the more developed countries (and because of their lack of comparability in performance or resources to the U.S., these less developed countries will not be considered further in any detail in this paper);

--scores for the United States become relatively lower at the higher age/grade levels, at least partly because the comprehensive structure of U.S. secondary schooling results in a much larger proportion of the relevant age group being included in the sample than for most other nations (see section D, especially table 4);

--U.S. scores are particularly low in the areas of French language skills and mathematics;

—United States scores are relatively high in science at population I, and reading comprehension, literature, and civic education at population II; and

—United States scores are at roughly the international mean for reading comprehension at population I, science at population II, and literature at population IV.

Thus, without any adjustment of the scores for students at population IV, the general impression of United States performance one derives from the first round IEA tests scores is that it ranks somewhat below the average for more developed countries, albeit with relatively higher performance at earlier grade levels in certain subjects (such as reading and science), but particularly low scores in mathematics and French as a foreign language. With respect to other more developed nations, there is no highly consistent pattern of certain nations being at the top or bottom on the basis of these test scores. However, this conclusion rests partially on the failure of some nations to participate in all subjects and at all age/grade levels—for example, Japan's performance is among the highest in most of the tests and levels at which it participated, but it did not participate at all of these.

ANALYSIS OF UNITED STATES SCORES ON FIRST ROUND IEA TESTS

Since the announcement of the results of the first round of IEA tests, much effort has been expended in analyzing the scores for the United States. This extensive literature is briefly considered below.

The main focus of attention in analyzing the United States scores has been the development of methods to adjust the population IV results to account for the widely varying proportions of the participating nations' youth included in the sample of pupils tested—students in the terminal year of pre-university secondary education. It has been traditional in most of the western European nations for only those who intend to matriculate at the university to complete

a general or academic upper secondary education. Especially at the time of the first round tests, other pupils in these countries would be directed to vocationally oriented secondary schools or would already be in the work force before the terminal year of pre-university secondary education. However, in the United States, all students in the 12th grade in our comprehensive high schools, except the small proportion in separate vocational schools were considered to be in population IV for the first round tests. In the mathematics tests, scores were reported separately for those students actually taking a mathematics course in their final secondary year. Table 4 below shows the proportions of the relevant age groups reported by each nation to be in population IV at the time of the first round test in science.

TABLE 4. Proportion of the Relevant Age Group Considered to be in Population IV at the Time of the First Round IEA Test in Science

Country	Percentage
Australia	29%
Belgium (Flemish)	47
Belgium (French)	47
Chile	16
England	20
Federal Republic of Germany	9
Finland	21
France	29
Hungary	28
India	14
Iran	9
Italy	16
Netherlands	13
New Zealand	13
Scotland	17
Sweden	45
Thailand	10
United States	75

NOTE: No listing is provided for Japan because it did not participate in the test at population IV.

Source: Wolf, Richard M. Achievement in America, p. 35.

To attempt to compensate for these wide disparities in the proportion of youth in pre-university secondary programs, many analysts have considered only the scores in each country of the top scoring percentage of pupils, such percentage to be equal to the lowest participation percentage for all of the countries. Thus, for the science examination, one might limit the analysis to the scores of the top scoring 9 percent of pupils in each country (equal to the lowest participation rate--that for West Germany and Iran). Employing this technique, the number of countries with scores above and below the U.S. mean score for population IV are as shown in table 5.

TABLE 5. Number of Countries With Mean Scores Above and Below the U.S. Mean in First Round IEA Tests for Population IV, Considering Only the Top Scoring 9 Percent of Pupils in Each Country

Test	Number of Countries Above U.S.	Below U.S.
Mathematics*	8	3
Science	6	11
Reading Comprehension	0	14
Literature	0	9
Civic Education	1	6

*Top 4 percent of scores compared for the mathematics test.

Sources: Wolf, Richard M. Achievement in America, p. 54. Torsten Husen. A Cross-National Perspective on Assessing the Quality of Learning, p. 45a.

Clearly, the relative position of the U.S. scores improves substantially when the population IV scores are adjusted as described above. Similar analyses of only the top 1 percent and 5 percent of scores in each country show a relative position for the U.S. almost identical to that for the top 9 percent. However, even with these adjustments, the relative position of the U.S. is strongest in reading comprehension and literature, becoming somewhat better than average (but still not among the top scoring countries) in science, and still below average in mathematics.

This technique of adjusting the population IV scores is not without its critics, although the critics have yet to develop an alternative method of adjusting the scores, which virtually all observers agree is necessary to put the population IV scores into a proper context. Critics have charged that

selecting only the top 9 percent (or 1 percent or 5 percent) of scores gives an unfair advantage to countries such as the United States with unselective systems of upper secondary education; that while the more limited group of upper secondary students in other countries includes most of the highest achievers, the selection process is not perfect nor is it based on academic achievement alone. They argue that the appropriate score for comparison purposes for such nations as the United States would be somewhere between the unadjusted scores and the score adjusted as described above.

In response, defenders of the adjustment process accuse the critics of logical inconsistency. They argue that the critics support selective systems of upper secondary education as providing the most efficient and appropriate education to the most academically talented students; therefore, they must accept the assumption that when scores are compared with those of other nations, the scores of those attending the selective upper secondary schools are indeed the top scores for the entire age group (i.e., that the scores for those not selected for pre-university education would have been lower if they had been tested). Further, defenders of the adjustment process argue that even this adjustment for selectivity may underestimate scores for population IV in countries such as the United States or Sweden where formal elementary and secondary education last 12 years, since they are being compared to countries (such as England, France, or West Germany) where pre-university secondary education continues through a 13th year.

Many analysts of the first round IEA test scores have concluded that after adjustment for selectivity at population IV, the differences in performance among the more developed countries are sufficiently small as to be relatively insignificant. For example, Alex Inkeles has concluded, ". . . [T]he school systems in the more developed countries are all more or less equally effective,

at least so long as the human material they are given to work with is roughly comparable, that is, has not been screened and selected to retain only the 'best' student." 2/ Similarly, Torsen Husen, a University of Stockholm professor who directed much of the first round testing process, argues that the test results show the top students performing at essentially the same level in all more developed countries, whether in comprehensive or selective secondary school systems, while those with average academic ability have more opportunity to develop their talents in comprehensive systems (i.e., that the majority of students are better off without damage to the learning opportunities for advanced students). 3/

However, other observers prefer to focus their attention on the fact that United States scores are below those of several other nations on most of the tests and age/grade levels, however the scores may be adjusted, and that United States scores in mathematics and foreign languages are well below the international average at population IV in all cases. In seeking an explanation for this level of performance, analysts have considered two major types of evidence, each of which will be considered only briefly in this paper:

—evidence regarding school system resources and practices gathered as a supplement to the first round IEA tests; and

—statements regarding the major values implicit in the structure and governance of American education, compared to those dominant in other highly developed countries.

As noted earlier, extensive information on pupil and school background characteristics was gathered as part of the IEA testing process. A thorough

---

2/ Inkeles, Alex. The International Evaluation of Educational Achievement, p. 176.

3/ Husen, Torsten. Are Standards in U.S. Schools Really Lagging Behind Those in Other Countries? Phi Delta Kappan, March 1983.

discussion of the development and intent of this process would be inappropriate in this paper, as such a discussion should be placed in the context of broader issues and debate regarding the effects of different school influences on academic achievement. For those interested, certain of the references listed at the end of this paper provide a thorough discussion of this aspect of the IEA's work. 4/ At this time, the background data collected and analyzed by the IEA will be considered only to the extent that arguments based on this information have been used to help explain the relative achievement scores of United States students compared to those of students in other nations.

Different types of background characteristics were found to significantly influence pupil achievement in between-country, as opposed to between-school or between-student, analyses. This paper is concerned only with the between-country analyses. The background data considered in the between-country analyses was intended primarily to help explain nationwide influences on average achievement, as opposed to more specific influences of particular home and school characteristics without regard to national boundaries, which are most often the focus of analyses of the sources of varying school achievement. This intent is reflected in the attribution of school average or even national average values of certain background variables to pupils, regardless of whether those values were appropriate for those individual pupils, in between-country analyses. This construction may have sharply limited the value of the data gathered for any further analysis because it greatly limited the degree of variation of the background characteristics (statistically, the less variation

---

4/ See, for example, Inkeles, Alex. The International Evaluation of Educational Achievement, and James S. Coleman, Methods and Results in IEA Studies of Effects on School Learning, Review of Educational Research, summer 1975.

of these "independent variables"—or background characteristics—the less they can be used to explain variation in the "dependent variables"—in this case, the achievement test scores). At least partly as a result, very few of the background factors were found to significantly affect achievement in comparisons between countries. In fact, the only consistently significant influence was found to be "opportunity to learn" or "time on task," the amount of time devoted to a particular subject area in the typical curriculum in each country. 5/

Thus, the low scores of American students in foreign languages (populations II and IV) and in mathematics (population IV) were—beyond selectivity factors—found to result largely from the relatively low emphasis given to those subjects in American schools. In the same fashion, it is argued that the relatively high scores of American pupils in reading comprehension and literature at certain age/grade levels are said to result from the relatively heavier emphasis on those subjects in American schools. Additional analysis focusing on the relationship between achievement growth and emphasis on science versus reading in the curricula of various countries for populations I and II has recently been published by James Coleman. 6/ Coleman found evidence in pupil achievement growth of an emphasis on science education in England, Scotland, Sweden, Hungary, Japan, and West Germany. This "time on task" effect would also be exercised in the aggregate via the greater total time spent in school

---

5/ In at least some subject areas, home and student background characteristics (family income, education, etc.) were found to most significantly influence achievement in between-school or between-student analyses. For example, see Science Education in Nineteen Countries, by L.C. Comber and John P. Keeves, Chapters 7-9.

6/ Coleman, James S. International Comparisons of Cognitive Achievement. Phi Delta Kappan, Feb. 1985. p. 403-406.

(i.e., longer school weeks or years, as well as the 13-year elementary-secondary curriculum for some pupils in certain nations) in some other countries compared to the United States. Thus, according to Inkeles, while differences in scores among the more developed countries are not great (after adjusting for selectivity for population IV), they can be consistent, and this regularity can be, "largely explained by objective factors readily observed and easily understood, such as differences in curriculum, the time available for studying a subject, and the selectivity of the school systems compared." 7/

Finally, others have looked to broader aspects of the values of American education that they consider to be implicit in its structure and governance to help explain relative American scores on the first round IEA tests. Primarily, these analysts argue that the historical emphasis of American education on access, equity, and equal opportunity has resulted in at least some diminution of the ability to maintain relatively high academic standards. They state that other nations' education systems, especially those of certain European nations, are more willing to maintain high standards, even at the expense of refusal of opportunity to a large proportion of their population to obtain the sort of education they might desire. (However, at least one major nation—Japan—appears to combine high secondary school achievement standards with a high rate of participation.) As examples of these contrasting values, observers have pointed to the selective systems of secondary education in many foreign

---

7/ See, for example, Inkeles, Alex. The International Evaluation of Educational Achievement, and James S. Coleman, Methods and Results in the IEA Studies of Effects on School Learning, Review of Educational Research, summer 1975.

countries compared to the comprehensive system in the United States; the rigorous competition for a limited number of college placements in several countries compared to the availability of some form of postsecondary education to virtually every high school graduate in the United States who desires to attend college (albeit with sharp competition for high prestige colleges); the standard-setting and, to a large extent, curriculum-directing role of national examinations for high school graduation in many foreign countries compared to only minimal competency examinations in certain American States; a purported lack of widely agreed upon and clearly articulated expectations of high academic achievement in such a heterogeneous nation as the United States; a system of tracking by ability and/or postsecondary education plans, which is delayed until senior high school and is of uncertain significance in the United States, compared to earlier differentiation into clearly distinguished institutions or programs in most foreign countries; and a greater emphasis on non-traditionally academic courses in the United States than abroad.

Additional arguments regarding the relatively disappointing United States performance in IEA tests have been offered in a recent article by Burton R. Clark, chairman of the Comparative Higher Education Research Group at the University of California, Los Angeles. 8/ According to Dr. Clark, the "downward coupling" of secondary with elementary schools in the United States has substantial, distinctive, and rarely noted effects on the level and nature of American secondary education. "Downward coupling" refers to the many ties between elementary and secondary education in the United States--administrative and financial linkages, essentially the same status and rewards for teachers,

---

8/ Clark, Burton R. The High School and the University: What Went Wrong in America, Part 1. Phi Delta Kappan, Feb. 1985. p. 391-397.

intended universality of both sectors, etc.,--and the relatively weaker ties between secondary and higher education in the United States. This pattern of intimate relationships between elementary and secondary education in the United States is in contrast to purportedly closer linkages between secondary and higher education in most other "advanced" nations. Clark argues that this results in a comparative dilution of the intensity, status, level, and quality of secondary education in the United States:

> Clearly, the comparisons that operate when different strata of personnel are grouped together within common administrative frameworks tend to pull secondary education toward the elementary school rather than toward the university. This is so natural a part of the U.S. educational system that it is rarely even considered, much less questioned. 9/

Evaluation of these arguments in an objective manner is in many cases impossible, since they are often based on subjective judgments. Certainly, education in the United States is governed and financed in a much more disaggregated fashion than in most other of the highly developed countries, yet this more clearly is likely to lead to a wider range of achievement levels in the United States (as appears to be the case from the IEA data) than a lower average. The effects of national examinations and of higher degrees of cultural homogeneity are so difficult to specify in concrete terms that they have not been satisfactorily evaluated empirically or objectively. Regarding the effects of tracking or selectivity of secondary school programs, as noted earlier, there are several analysts who interpret the IEA results as indicating that nations with comprehensive secondary education systems provide greater academic opportunity to students of average ability while not reducing significantly the achievement level of the most talented students. Further, at

---

9/ Ibid., p. 394.

least one participant in most of the IEA tests--Japan--now appears to have a higher rate of completion of secondary education than does the United States although with a competitive system for high school entrance. It has also been argued that at least at the postsecondary level, American colleges--with their relatively high drop-out rates--are also rather selective, but that the selection process takes place via attrition rather than through rigorous entrance examinations.

AVAILABLE IEA SECOND ROUND TEST RESULTS

As indicated earlier, the initial results of the second round IEA tests in science and mathematics have been released, at least for the United States. For the mathematics test, final United States test results are now available, along with limited comparisons to test results for other participating nations. Certain information on educational processes collected as part of the mathematics test in the United States and six other countries, along with additional analyses of test results, are not yet available. For the science test, only certain test results for the United States are now available.

The second round mathematics test included students at age 13 (grade 8 in the United States) and the terminal year of secondary education (age 17, grade 12 in the United States). For the sake of consistency with the earlier portions of this paper, these two groups will be labelled population II and IV, respectively. Participating students in the United States included 7,000 8th-graders and 4,500 12th-graders in 250 public and private schools, who took the tests in 1982. The study included not only the administration of mathematics tests but also surveys of classroom processes and of mathematics curricula--not only as intended but also as actually implemented and attained.

At the 12th grade level, two American population groups were tested. One included only the 2-3 percent of American high school seniors taking a full-year course in calculus. The second group included other high school seniors who were taking college preparatory mathematics currently and had previously taken at least two years of algebra and one year of geometry. Altogether, these two groups were found to constitute only 10-12 percent of United States high school seniors--a percentage lower than in most of the other participating countries, as indicated in the following table.

TABLE 6. Percentage of Relevant Age Group Included in Population IV for the Second Round IEA Test in Mathematics

Nation	Percentage of relevant age group
Belgium (Flemish)	9-10%
Canada (British Columbia)	30%
Canada (Ontario)	19%
England and Wales	6%
Finland	15%
Hungary	50%
Israel	6%
Japan	12%
New Zealand	11%
Scotland	18%
Sweden	12%
United States	10-12%

a/ The age groups is the average age of students in their final year of secondary education—in the United States, age 17. The students tested in this age group were those taking college preparatory mathematics currently, and who had previously taken the equivalent (in United States terms) of two years of algebra and one year of geometry.

Source: Second International Mathematics Study, Summary Report for the United States, p. 6.

Thus, the complaint frequently made in the past that international achievement comparisons at the upper secondary level were unfair to the United States, because of the purportedly higher proportion of our youth completing secondary education than in most other countries with more "selective" systems of secondary education, would not apply to this second IEA mathematics test. Only in Israel and England/Wales did the second round mathematics test for population IV cover a significantly smaller percentage of the relevant age group than in the United States.

Comparisons of the results for United States students to those of other participating nations have been presented in two different forms. First, aggregate average scores at each of the two age levels have been reported for the United States and most of the other "advanced" nations included in the study. A graphic display of such scores was presented in the recent U.S. Department of Education publication, "What Works." 10/ On the basis of such aggregate scores, United States students scored below all but two of 14 "advanced countries" at the population II level. The United States score was 48 percent of the questions correct, while the international average (mean) was 52 percent, and the highest score (for Japan) was 64 percent. At the population IV level, and considering only the top 5 percent of scores in each country, the United States score was the lowest of those for 12 "advanced countries." The United States score was 52 percent correct while the highest score (again, for Japan) was 66 percent.

However, a perhaps more useful and informative comparison of United States and other nations' scores is that based on individual mathematics subject areas

---

10/ U.S. Department of Education. What Works, Research About Teaching and Learning. Washington, 1986. p. 28 and 30.

on which students were tested. Shown below (table 7) are United States and international average (median) scores for each of the 5 mathematics subject areas on which population II students were tested.

TABLE 7. Scores on Individual Mathematics Tests for Population II Students (8th Grade): United States and International Averages

Subject area	United States average score	International median
Arithmetic	51%	51%
Algebra	43%	43%
Geometry	38%	43%
Measurement	42%	51%
Statistics	57%	57%

Source: Travers, Kenneth J. and Curtis C. McKnight. Mathematics Achievement in United States Schools: Preliminary Findings from the Second IEA Mathematics Study. Phi Delta Kappan, Feb. 1985. p. 410.

This presentation of test results not only provides additional detail as to the specific areas of weakness of United States students, but also puts the United States scores overall in somewhat more favorable light. Scores for United States 8th grade students were at precisely the international median for arithmetic, algebra, and statistics. United States scores were below average only in the areas of measurement--where relative unfamiliarity with the metric system places American students at a disadvantage--and geometry. An analysis of the coverage of material on the tests by the typical curriculum in different nations determined that of the five subject areas above, American students had

least exposure to the material covered by the geometry test. Typically, foreign students in population II had received substantially greater exposure to geometry than had American students, who usually do not receive substantial instruction in geometry before the ninth grade. In addition, according to the United States coordinator for the second round IEA mathematics tests, "[F]rom the perspective of other nations, the eighth-grade mathematics curriculum in the United States looks more like a program of studies for the end of elementary school than for the beginning of high school." 11/ This was combined with the finding of a great deal of diversity in the level of mathematics courses offered to students in different localities in the United States at this grade level. Finally, a comparison of United States scores at the population II level between 1964 (the first round IEA test) and 1982 showed slight declines, especially in items associated with higher cognitive--as opposed to computational--skills.

Scores of United States students, in comparison to international averages, on the individual mathematics tests administered to population IV (12th grade) students are shown below (table 8). The United States scores are shown separately for the calculus and other ("precalculus") students included in the United States sample, as well as a weighted average of scores of all United States students in population IV. The international average scores are based on all of the students in each of the participating nations.

11/ Travers, Kenneth J. and Curtis C. McKnight. Mathematics Achievement in U.S. Schools: Preliminary Findings from the Second IEA Mathematics Study. Phi Delta Kappan, Feb. 1985. p. 409.

TABLE 8. United States and International Average Scores on Individual Tests in the Second IEA Mathematics Study, Population IV (12th Grade)

Subject area	United States average			International median
	Calculus	Precalculus	Overall	
Algebra	57%	40%	43%	57%
elementary functions and calculus	49%	25%	29%	46%
"Finite mathematics"	38%	29%	31%	44%
Geometry	38%	30%	31%	42%
Number systems	48%	38%	40%	47%
Probability and statistics	48%	39%	40%	46%
Sets and relations	64%	54%	56%	61%

a/ "Finite mathematics" includes calculations, permutations, and combinations of number sets of finite size (as distinguished from the number sets of potentially infinite size which are associated with the functions analyzed in calculus), such as the binomial theorem [which gives values for functions of the form, (a+b) to the nth power]. Such topics are often taught in the United States in high school mathematics classes above the level of trigonometry but below calculus. Such courses are often called "mathematics analysis" classes.

Source: Travers, Kenneth J. and Curtis C. McKnight. Mathematics Achievement in U.S. Schools: Preliminary Findings from the Second IEA Mathematics Study. Phi Delta Kappan, Feb. 1985. p. 412.

The United States students' combined scores (weighted average of calculus and precalculus classes) were below the international average in all subject areas—particularly algebra, geometry, elementary functions and calculus, and "finite mathematics". For calculus classes in the United States only, scores

were at or slightly above the international average in the areas of sets and relations, number systems, algebra, elementary functions and calculus, plus probability and statistics. Scores were below the international average for all United States classes in geometry and "finite mathematics."

Thus, this more detailed analysis of scores is less favorable to the United States for population IV students than it was for population II students. While United States high school seniors in calculus classes score at about the international average in several mathematics subject areas, these individuals represent only 2-3 percent of all students, and are being compared to all students tested (see table 6) in other countries, not just the top scoring 2-3 percent. As noted earlier (p. 25), a comparison on the basis of population IV combined scores in all mathematics subject areas for the top 5 percent of students in each participating country placed United States scores last of twelve "advanced countries." It is difficult to escape the conclusion that the performance of United States high school seniors is relatively poor in mathematics by international standards. A separate comparison of the scores of United States students in population IV between 1964 and 1982 found modest gains in most subject areas over this period.

In attempting to explain the relatively disappointing United States mathematics scores at the population IV level, the United States coordinators of this study have pointed to the great diversity of curricular offerings, and the purportedly "low intensity" of United States mathematics instruction mentioned above with respect to the population II scores. Also noted with respect to the scores for older students is the "fragmentation" of the United States high school mathematics curriculum—the teaching of algebra, geometry, etc., as separate subjects with little integration--which is not emulated in most other "advanced" countries.

Limited information, for the United States only, is available on the results of the second IEA test in science. Scores for the other 24 nations taking part in this test may be available later in 1986. In the United States, students in 125 public and private schools took part in science tests administered at the 5th (population I), 9th (population II), and 12th (population IV) grade levels. Further, the United States 12th grade students were divided into two groups—those taking courses in physics and those taking no science courses in their senior year of high school. Given the lack of scores for foreign nations, these science test scores can be meaningfully considered at this time only in the context of comparisons with scores on the first round science test, in 1970. According to the United States coordinators of this study, sufficient test items have been included to provide comparisons of the overall scores of population I (5th grade) and II (9th grade) students between 1970 and 1983. 12/ Scores for population I students in the United States rose from 59.0 percent correct in 1970 to 62.5 percent in 1983; for population II, scores rose from 56.7 percent to 59.5. Thus, the comparison over time of United States students' scores would indicate modest improvement. However, further analysis of these findings, as well as their comparison with international standards, will have to await further study findings from the United States and abroad.

12/ Jacobson, Willard J. and Rodney L. Doran. The Second International Science Study: U.S. Results. Phi Delta Kappan, Feb. 1985. p. 415.

APPENDIX: SIGNIFICANT, RECENT, NON-IEA RESEARCH ON COMPARATIVE ACHIEVEMENT

Two other recent, comparative achievement research activities are worthy of mention, although each is far less extensive than the IEA, primarily because they are limited to the United States and Japan (plus, in one case, Taiwan). At a biannual meeting of United States and Japanese government officials in Washington in July of 1984, it was proposed that the two governments engage in a 2-year comparative study of secondary education. Japanese education officials are conducting a study of the United States' education system, while U.S. Department of Education staff are studying Japanese education. The United States effort is being directed by Larry Grayson of the U.S. Office of Educational Research and Improvement. The two reports are scheduled to be released in October 1986.

The second study was directed by Professor Harold W. Stevenson of the University of Michigan's Center for Human Growth and Development. In this project, a limited number of elementary pupils were extensively observed in classroom settings in the United States, Japan, and Taiwan. Although a total of 1,400 first and fifth grade pupils in the three countries were tested and observed, these samples are rather small compared to those for the IEA tests. The basic strategy for this research was to focus on detailed testing and observation of a relatively small number of pupils and classrooms. This was done under the assumption--but far less assurance than with the much larger IEA

samples—that these are reasonably representative of each nation at large. 13/ Under this approach, substantial information on classroom environment, teaching techniques, and parental attitudes could be collected—in other words, there was much more intensive development of a smaller sample of pupils, in fewer countries, compared to the IEA.

The results of this study have been reported in a recently published monograph and several journal articles. 14/ The achievement test scores in reading and mathematics for first and fifth graders are listed below.

13/ In fact, the United States classroom sample, taken from schools in Minneapolis, Minn., is clearly unrepresentative of the United States at large in at least one respect—its low proportion of minority or recent immigrant pupils. However, this is likely to make the United States scores in this study higher than they would be with a more representative sample. The Japanese and Taiwanese samples were also taken from single cities of similar size to Minneapolis (Sendai, Japan and Taipei, Taiwan).

14/ U.S. Pupils Lag From Grade 1, Study Finds. New York Times. June 17, 1984. Mathematics Achievement of Chinese, Japanese, And American Children. Science. February 14, 1986. Cognitive Performance And Academic Achievement Of Japanese, Chinese, And American Children. Child Development. 1985. vol. 86. Making The Grade: School Achievement In Japan, Taiwan, And The United States. Annual report of the Center for Advanced Study in the Behavioral Sciences. 1983. Child Development And Education In Japan. New York, N.Y. W. H. Freeman. 1986.

TABLE 6. Achievement Test Scores of First and Fifth Grade Pupils in the United States, Japan and Taiwan in University of Michigan Study
(Mean number of questions answered correctly)

Nation	Mathematics	Reading comprehension
	First Grade	
United States	17.1	21.3
Japan	20.1	22.8
Taiwan	21.2	25.7
	Fifth Grade	
United States	44.4	82.7
Japan	53.3	82.5
Taiwan	50.8	84.6

Source: Cognitive Performance And Academic Achievement Of Japanese, Chinese, And American Children. Child Development. Vol. 86. 1985. p. 718-734.

These achievement test scores indicate that while reading achievement is relatively similar among the three countries (and becomes more so at the higher grade level), the United States performance is distinctly behind that of the other two countries in mathematics at both grade levels (at the fifth grade level the United States performance is further behind the leading country in absolute terms but slightly less far behind in proportional terms). This repeats a pattern evident in the IEA findings of relative strength of United States performance in reading but weakness in mathematics achievement. This impression is further corroborated by findings from the University of Michigan study that American pupils in the fifth grade spend much more of their class time on reading lessons than do pupils in the other countries (41.6 percent in the United States compared to 24.0 percent in Japan and 27.6 percent in

Taiwan); and less on mathematics (17.2 percent for the United States compared to 23.4 percent in Japan and 28.2 percent in Taiwan). This finding is also consistent with IEA conclusions on the importance of time on task and curricular emphasis in explaining achievement patterns.

Of special interest are the findings of the University of Michigan study regarding classroom environment and activities. Certain conventional measures of quality of educational inputs—especially class size and such formal teacher qualifications as degrees or years of education—were found to be more favorable in the United States. However, the researchers found substantial differences among the countries in the proportion of class time actually devoted to academic pursuits. They determined that in their sample of American classrooms, the average pupil spent less than one-half of his or her time paying attention to academic instruction (45.3 percent for the first grade and 46.5 percent for the fifth), while pupils in Japan and Taiwan spent approximately two-thirds or more of their time so engaged (66.2 percent and 64.6 percent for the first and fifth grades in Japan, 65.0 percent and 77.7 percent for these grades in Taiwan). American teachers were judged to be imparting information to their pupils only 21 percent of the time, compared to 33 percent in Japan and 58 percent in Taiwan. Combined with the longer school week and year in the two Asian countries (for example, the average school year is 240 days in Japan and Taiwan compared to 180 days in the United States), this leads to substantially greater aggregate time spent on academic activities in Japan and Taiwan. 15/

15/ Contrary to popular impressions, fewer then 10 percent of the pupils in any of the 3 nations were found to be taking academically-oriented tutorial classes before or after school. While such classes are common in Japan, they appear to be limited primarily to secondary education.

Ironically, in view of the lower performance of American pupils, a survey of their parents indicated a higher level of satisfaction with their children's schools and academic progress than was the case for Japanese or Taiwanese parents. While 92 percent of American mothers rated their children's schools as "good" or "excellent," such ratings were given by only 39 percent of Japanese mothers and 42 percent of those in Taiwan. It was also determined that American parents are less willing than those in the other countries to push their children to improve their level of achievement; and that American parents are more likely to assign non-academic chores to their children while Japanese and Taiwanese parents are more concerned to leave their children free to pursue homework and other academically related activities at home. Compared to Japanese and Taiwanese children, American first- and fifth-graders were found to spend more out-of-school time playing, performing household chores, or sleeping, but less time on homework or reading for pleasure. However, Japanese children were found to spend the most time watching television.

Interesting differences were found among the three nations in the extent to which mothers attributed academic performance to pupil effort versus native ability. Compared to the two Asian nations, American mothers were more likely to emphasize ability, rather than effort, as a basis for success in school. It was suggested that, "[T]he willingness of Japanese and Chinese children to work so hard in school may be due, in part, to the stronger belief on the part of their mothers in the value of hard work." 16/ There were significant differences in education-related resources in the home--e.g., while fewer than two-thirds of the United States pupils had study desks at home, more than 95 percent of the Japanese and Taiwanese pupils had such desks. Further, Japanese

---

16/ Mathematics Achievement Of Chinese, Japanese, And American Children. Science. February 14, 1986. p. 697.

and Taiwanese mothers reported spending more time assisting in and supervising their children's homework.

Finally, the group of researchers lead by Stevenson concluded that, contrary to the arguments of some analysts, 17/ the greater achievement in mathematics by Japanese and Taiwanese children did not result from higher average levels of intelligence or native ability in the Asian nations. Several tests of aspects of innate ability were administered to the pupils and, while there were significant differences in scores on certain of these tests, the score rankings did not consistently favor one nation over the others. It was determined that on average, children in the three nations were much more alike than different in basic cognitive ability. It is assumed, therefore, that differences in academic achievement are the result of school and home influences, not innate intelligence.

17/ Lynn, R. IQ in Japan and the United States Shows a Growing Disparity. Nature. 1982. p. 222-223.

REFERENCES

Clark, Burton R. The high school and the university: what went wrong in America, part 1. Phi Delta Kappan, Feb. 1985: 391-397.

Coleman, James S. International comparisons of cognitive achievement. Phi Delta Kappan, Feb. 1985: 403-406.

----- Methods and results in the IEA studies of effects of school on learning. Review of educational research, summer 1975: 335-386.

Comber, L.C. and John P. Keeves. Science education in nineteen countries. New York, John Wiley and Sons, 1973. 403 p.

Education Daily. U.S. students improve in science, new study shows. May 30, 1984: 1.

----- Comparative study of U.S., Japanese education proposed. Aug. 1, 1984: 6.

Education Times. A summary of findings from U.S. in the second international mathematics study. Oct. 8, 1984: 2, 6.

----- Eighth and twelfth grade math study charts intended, implemented, attained curriculum. Oct. 15, 1984: 5-6.

Education Week. International math assessment find U.S. students 'average.' May 16, 1984: 1, 17.

-----Study finds Achievement Up in Biology, Physical Sciences. June 6, 1984: 9.

Fiske, Edward B. American students score average or below in international math exams. New York times, Sept. 23, 1984: 30.

----- U.S. pupils lag from grade 1, study finds. New York times, June 17, 1984: 1, 30.

Holsinger, Donald B. Time, content, and expectations as predictors of school achievement in the USA and other developed countries: a review of IEA evidence. Prepared for the National Commission on Excellence in Education, Sept. 28, 1982. 51 p.

Hurn, Christopher J., and Barbara B. Burn. An analytic comparison of educational systems: overview of purposes, policies, structures and outcomes. Prepared for the National Commission on Excellence in Education, Feb. 1982. 80 p.

Husen, Torsten. A cross-national perspective on assessing the quality of learning. Prepared for the National Commission on Excellence in Education, (undated, but apparently completed in 1982). 51 p.

----- An international research venture in retrospect: the IEA surveys. Comparative education review, Oct. 1979: 371-385.

----- Are standards in U.S. schools really lagging behind those in other countries? Phi Delta Kappan, Mar. 1983: 455-461.

Inkeles, Alex. The international evaluation of educational achievement. Wash., D.C.: National Academy of Education, 1977. 61 p.

----- National differences in scholastic performance. Comparative Education Review, Oct. 1979: 386-407.

International Association for the Evaluation of Educational Achievement. Second study of mathematics, United States summary report. The Association, U.S. National Coordinating Center, Univ. of Ill., Urbana-Champaign, Sept. 1984. 97 p.

Jacobson, Willard J., and Rodney L. Doran. The second international science study: U.S. results. Phi Delta Kappan, Feb. 1985: 414-417.

Lerner, Barbara. American education: how are we doing? The public interest, fall 1982: 59-82.

Lynn, R. IQ in Japan and the United States shows a growing disparity. Nature, 1982: 222-223.

Passow, A. Harry. The I.E.A. National Case Study. The educational forum, summer 1984: 469-487.

Peaker, Gilbert F. An empirical study of education in twenty-one countries: a technical report. New York, John Wiley and Sons, 1975. 230 p.

Resnick, Lauren B., and Daniel P. Resnick. Standards, curriculum, and performance: a historical and comparative perspective. Prepared for the National Commission on Excellence in Education, Aug. 31, 1982. 53 p.

Stevenson, Harold. Child development and education in Japan. New York, W.H. Freeman. 1986.

----- Making the grade: school achievement in Japan, Taiwan, and the United States. Annual report of the Center for Advanced Study in the Behavioral Sciences. 1983. p. 41-51.

Stevenson, Harold, Shin-Ying Lee, James W. Stigler, G. William Lucker, Seiro Kitamura, and Chen-chin Hsu. Cognitive performance and academic achievement of Japanese, Chinese, and American children. Child development, vol. 86, 1985: p. 718-734.

Stevenson, Harold, Shin-Ying Lee, and James W. Stigler. Mathematics achievement of Chinese, Japanese, and American children. Science, Feb. 14, 1986: p. 693-699.

Theisen, Gary L., Paul P.W. Achola, and Francis Musa Boakari. The underachievement of cross-national studies of achievement. Comparative Education review, Feb. 1983: 46-68.

Travers, Kenneth J., and Curtis C. McKnight. Mathematics achievement in U.S. schools: preliminary findings from the second IEA mathematics study. Phi Delta Kappan, Feb. 1985: 407-413.

U.S. Department of Education. National Center for Education Statistics. Second international mathematics study, summary report for the United States. Washington, D.C. May 1985. 139 p.

U.S. Library of Congress. Congressional Research Service. Public Secondary Education Systems in England, France, Japan, the Soviet Union, the United States, and West Germany: a comparative analysis. [Washington] 1984. 38 p. (CRS Rept. No. 84-770).

----- Selected educational expenditures and participation statistics for the United States and certain foreign nations. [Washington] 1984. 6 p.

Walberg, Herbert J. Scientific literacy and economic productivity in international perspective. Daedalus, spring 1983: 1-28.

Wolf, Richard M. Achievement in America. New York, Teachers College press, 1977. 192 p.

----- American education: the record is mixed. The public interest, summer 1983: 124-128.